

ECE 321 - Homework #1

Op Amp Amplifiers, Push-Pull Amplifiers. Due Monday, April 3rd
Please email to jacob.glower@ndsu.edu, or submit as a hard copy, or submit on BlackBoard

For all problems, assume you are using

- LM833 Op Amps (max current = 50mA)
- 2SC6144 transistors ($\beta = 200$, 10A max, $|V_{be}| = 0.7V$), or
- TIP112 / TIP117 NPN and PNP power transistors (for a push-pull amplifier).
 - $\beta = 1000$, 3A max, $|V_{be}| = 1.4V$

Amplifier:

1) Design a circuit to implement

- a) $Y = +4X$
- b) $Y = -4X$
- c) $Y = 12 - 4X$

Mixer

2) Design a circuit to mix three signals together:

- $Y = 6A + 3B + 7C$

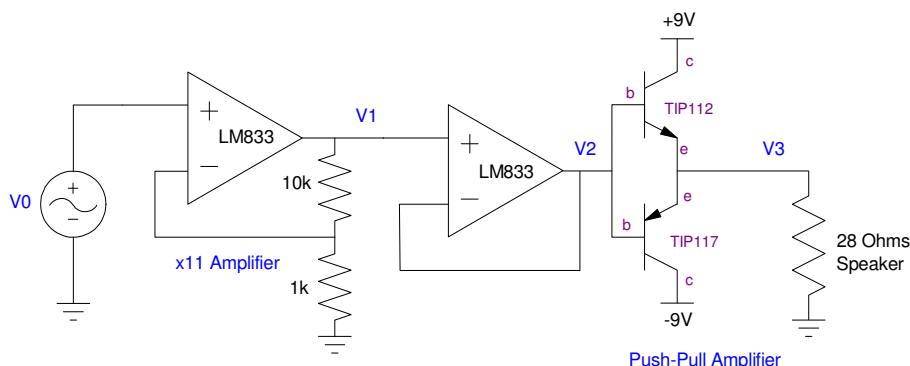
Push-Pull Amplifier with Crossover Distortion

3) For the circuit below, calculate the voltages and currents when

- $V_1 = +0V$
- $V_1 = +1V$
- $V_1 = +2V$

4) Simulate in CircuitLab with

- V_1 being a 4Vpp sine wave at 1kHz, or
- V_0 being a 363mVpp sine wave at 1kHz (same result)



Problem 3-5: Amplifier with Crossover Distortion

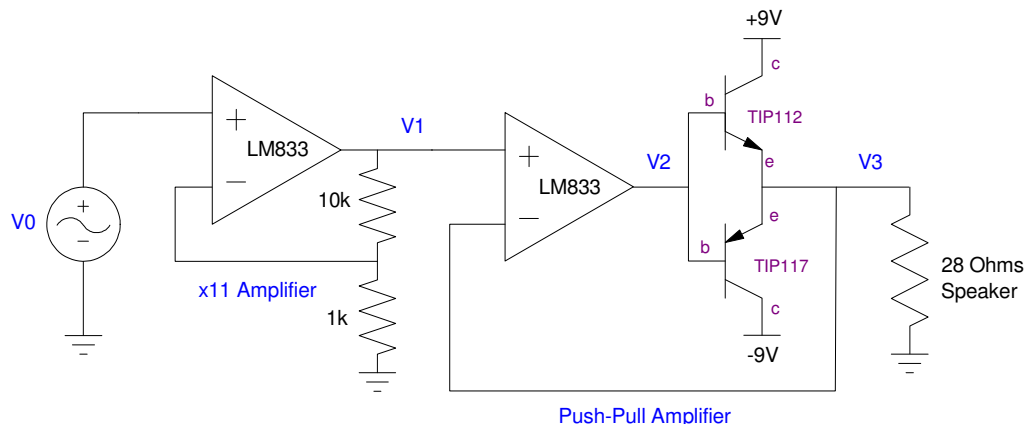
Push-Pull Amplifier without Crossover Distortion

5) For the circuit below, calculate the voltages and currents when

- $V_1 = +0V$
- $V_1 = +1V$
- $V_1 = +2V$

6) Simulate in CircuitLab with

- V_1 being a 4Vpp sine wave at 1kHz, or
- V_0 being a 363mVpp sine wave at 1kHz (same result)

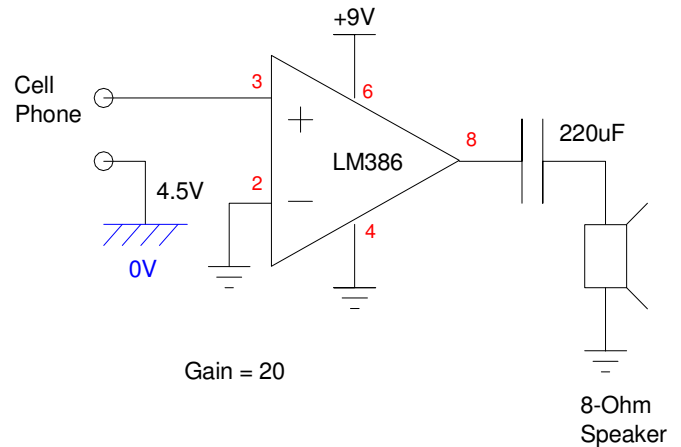
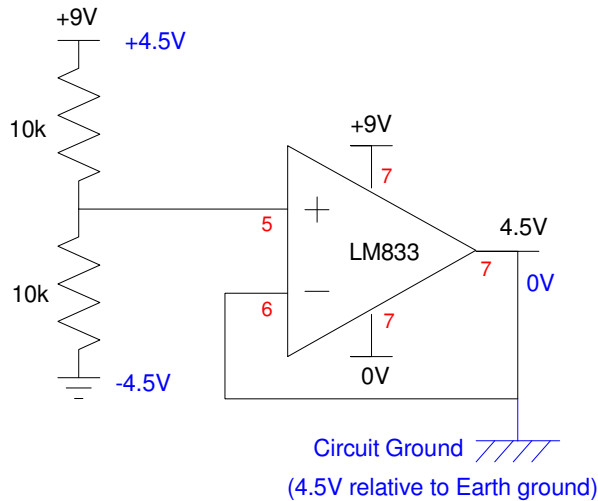


Problem 5 -6: Amplifier Without Crossover Distortion

Lab

(over)

An LM386 is a 700mW audio amplifier (essentially a push-pull anmplifier on a chip - provides better sound quality).



- 7) Build the two circuits above on a breadboard using a 9V battery (or any 6-12VDC power source)
- Creating a 4.5V reference signal (acts as circuit ground) capable of sourcing / sinking up to 25mA
 - A gain of 20 audio amplifier (LM386)

Include photo of your resulting breadboard circuit.

- 8) Check the functioning of the 4.5V reference source (LM833) under load. Measure the output voltlage with
- No load on the output.
 - The output connected to +9V through a 220 Ohm resistor (sinking 20.5mA)
 - The output connected to 0V through a 220 Ohm resistor (sourcing 20.5mA)

- 9) Check the functioning of the audio amplifier (LM386) under load (connected to an 8-Ohm speaker). Connect the input to a function generator (cell phone app preferred). Measure the gain when the input is
- A 200Hz sine wave
 - A 1kHz sine wave
 - A 5kHz sine wave

note: Keep your circuit together - we'll use it for the next few weeks.